Goddard Space Flight Center
Greenbelt, MD

HITCHHIKER REACTIVATION PLAN – PROJECT-WIDE

870-PLAN-083

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1.0 Introduction

The Hitchhiker (HH) Program was initiated in early 1984 by the NASA Office of Space Flight with the objectives of providing a quick reaction and low cost capability for flying small payloads in the shuttle payload bay. Between 1986 and 2003 sixty-nine Hitchhiker experiments were flown on twenty-nine Hitchhiker payloads. In 2004 funding for the Hitchhiker program stopped. Consequently most of the Hitchhiker hardware was put into storage and the Hitchhiker project was terminated.

The HH carrier systems were initially developed out of a concern by NASA that once the primary payloads in the shuttle were manifested there were available resources going to waste. Therefore the HH carrier systems were designed to be modular and reconfigurable to accommodate the available resources of each shuttle mission. The HH carrier systems were thus interfaced to standard orbiter mechanical and electrical interfaces as defined in the *Small Payload Accommodation Interface Definition Document, NSTS-21000-IDD-SML*, as well as the *Shuttle/Payload Interface Definition Document for Standard Accommodations, NSTS 21000-IDD-STD*. The HH carrier systems were also designed to ease the process of customer integration to the carrier systems and ease the process of payload integration into the Orbiter.

1.1 Purpose

This document is meant to serve as a guide to anyone who may desire to make use of the Hitchhiker hardware that was put into storage.

1.2 Scope

This Hitchhiker Reactivation Plan is a top-level document. It provides an overview of the Hitchhiker hardware and capabilities. This plan should serve as a starting point for reactivating the Hitchhiker hardware. Individual reactivation plans have been developed for each engineering discipline and are referenced herein.

This plan and the reactivation plans referenced were written to meet the requirements to fly onboard the space shuttle at the time they were written. Since those requirements are likely to change over time, it is recommended that the requirements applicable at the time of the use of this plan be consulted in conjunction with its use.

1.3 Applicable Documents

740-SPEC-008	Hitchhiker Customer Accommodations Requirements (CARS)
870-MGMT-018	SSPP Risk Management Document
870-PLAN-047	Shuttle Small Payloads Project Office (SSPPO) Project Plan
870-PLAN-084	Hitchhiker (HH) Reactivation Plan - Mechanical
870-PLAN-085	Hitchhiker (HH) Reactivation Plan - Electrical
870-PLAN-086	Hitchhiker (HH) Reactivation Plan - Ground Data Systems (GDS)
870-PLAN-087	Hitchhiker (HH) Reactivation Plan - Thermal

870-PLAN-088	Hitchhiker (HH) Reactivation Plan - Documentation
870-PLAN-089	Hitchhiker (HH) Reactivation Plan - System Safety
870-PLAN-090	Hitchhiker (HH) Reactivation Plan - Mission Assurance
870-PLAN-091	Hitchhiker (HH) Reactivation Plan – Operations
870-SFTY-081	System Safety Implementation Plan For The SSPPO
ICD-2-19001	Shuttle Orbiter / Cargo Standard Interfaces (Core)
NASA/CP-1999-209476	NASA Shuttle Small Payloads Symposium proceedings
NASA-TM-211611	Integration & Test of Shuttle Small Payloads
NSTS-21000-IDD-SML	Small Payload Accommodation Interface Definition Document
NSTS 21000-IDD-STD	Shuttle/Payload Interface Definition Document for Standard Accommodations
NSTS21000-SIP-ATT	Shuttle/Payload Standard Integration Plan for Attached Payloads
NSTS 21000-SIP-DRP	Shuttle/Payload Standard Integration Plan for Deployable/Retrievable Payloads

1.4 Acronyms

CARS	Customer Accommodations Requirements
CG	Center of Gravity
FSW	Flight Software
GDS	Ground Data Systems
HH	Hitchhiker
I&T	Integration and Test
ICD	Interface Control Document/Drawing
IDD	Interface Definition Document
JSC	Johnson Space Center
KSC	Kennedy Space Center
NASA	National Aeronautics and Space Administration
PDI	Payload Data Interleaver
PES	Pallet Ejection System
PIP	Payload Integration Plan
PSP	Payload Signal Processor
PSRP	Payload Safety Review Panel
SHELS	Shuttle Hitchhiker Experiment Launch System
SIP	Standard Integration Plan
SSP	Space Shuttle Program
SSPPO	Shuttle Small Payloads Project Office

2.0 HH Description

The Hitchhiker carrier system was designed to be modular and expandable in accordance with payload requirements. This flexibility allows maximum efficiency in utilizing Orbiter resources and increases the potential for manifesting on the Shuttle.

The following is a description of the major elements of the Hitchhiker carrier system. A more complete description of the carrier system can be found in 740-SPEC-008, *Hitchhiker Customer Accommodations Requirements (CARS).*

The **sealed canister** (no door) can accommodate a customer payload of up to 200 pounds, 19.75 inches in diameter and 28.25 inches long. Longer canisters are also possible. There is also a Hitchhiker **motorized door canister**, which will accommodate 160 pounds of customer payload. The canisters may be insulated or un-insulated depending on the customer's heat rejection requirements.

The vertical **Experiment Mounting Plate** provides a 25 by 39 inch mounting surface for up to 200 pounds of customer hardware. The plate accepts 3/8-inch bolts on 70-millimeter centers and can be equipped with heaters, thermostats and thermistors for maintaining and measuring thermal control of the plate and mounted hardware. Power for the heaters is provided by connection to the HH avionics.

The **GAS Adapter Beam** is normally used for Orbiter side-mounted equipment (see Figure 2-1). The beam attaches to the Orbiter longeron and frame structure. The side-mount Hitchhiker system may be installed in Bays 2-8 or Bay 13, port or starboard. The Adapter Beam can hold one canister or mounting plate and the Hitchhiker avionics box, which connects the power, data and signal from the Shuttle to the experiments. Additional Adapter Beams can hold up to 2 canisters, or plates, or one of each, per beam.

Figure 2-1 Side Mounted Canisters

A **Hitchhiker cross-bay carrier** can be located anywhere in the payload bay except bay 13 (see Figure 2-2). The carrier structure has mounting slots on its sides, which can accommodate up to seven canisters or 25 by 39 inch plates. Four additional mounting slots are located on the top of the carrier and will accept **33 by 27 inch pallets** or **33 by 55 inch pallets** (2 slots) in any combination with up to 250 pounds or 500 pounds of equipment respectively. Customer hardware that can be accommodated on the small plate or in a canister can therefore be flown on either side-mount or cross-bay carriers and has the greatest manifesting flexibility.

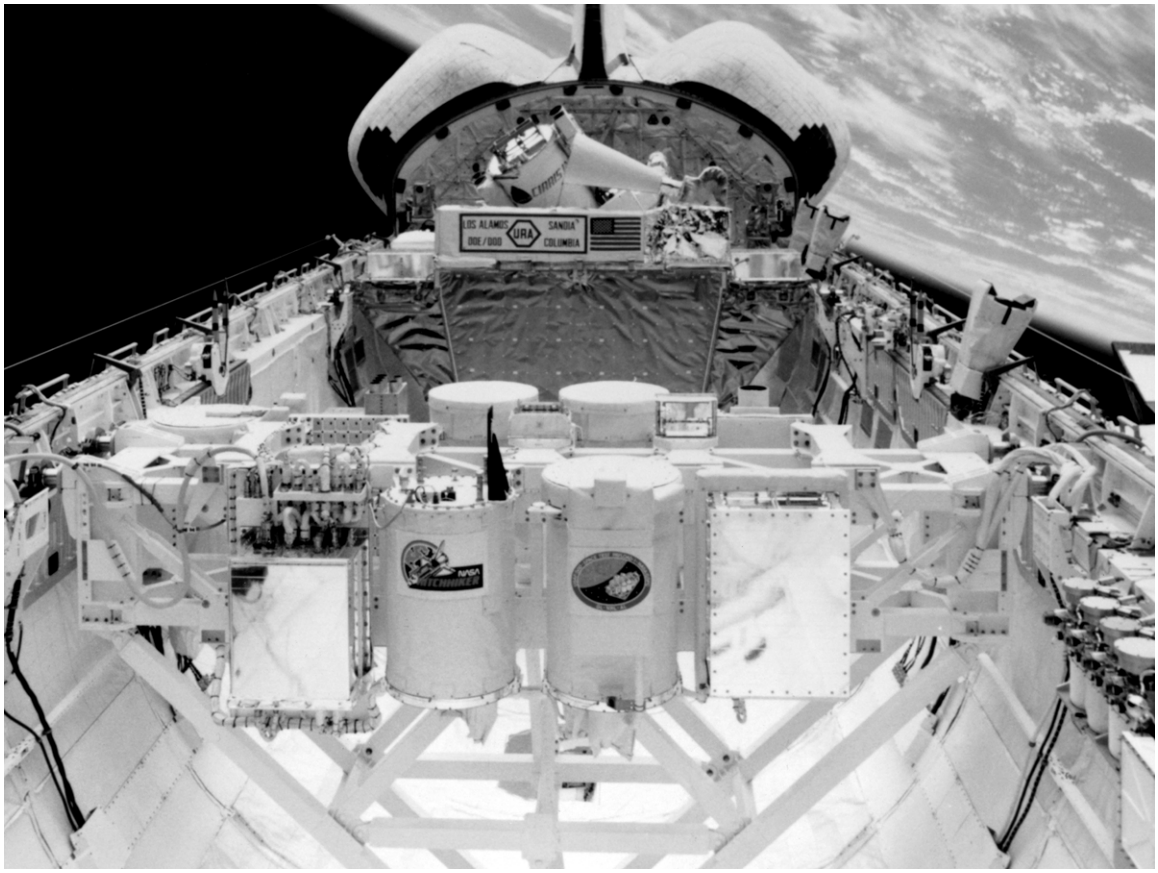

Figure 2-2 Cross-Bay Hitchhiker

The **Hitchhiker Avionics Unit** provides standard electrical interfaces or "ports" for up to eight customer payloads and may be used in both the side-mount and the cross-bay payload configurations. It contains a microprocessor control unit, relay switching equipment, medium rate multiplexer, and other hardware necessary to interface with the customer hardware and Orbiter. A switch panel in the cabin allows the crew to activate and deactivate the payload and provides an independent command path to control inhibits to any hazardous functions. The crew controlled Payload and General Support Computer laptop may also be used for back up or expanded command and telemetry options. In addition to these standard interfaces, connections can be provided to allow customer use of the Orbiter Closed Circuit Television System, or crew control and display systems. The avionics uses the low rate Orbiter Payload Signal Processor (PSP) system for commanding and Payload Data Interleaver (PDI) for low-rate telemetry. The avionics uses the Orbiter Ku band system for medium rate telemetry. Customer interfaces to the avionics are detailed in the CARS document.

In order to provide low cost, quick reaction, and increased autonomy for the customer, the carrier has been implemented with a transparent data system concept (see **Figure 2-3**). The Customer provided Ground Support Equipment, associated software, and personnel can be used to generate commands to the customer's payload and display data from the payload during payload-to-carrier integration and verification testing, and also during flight operations.

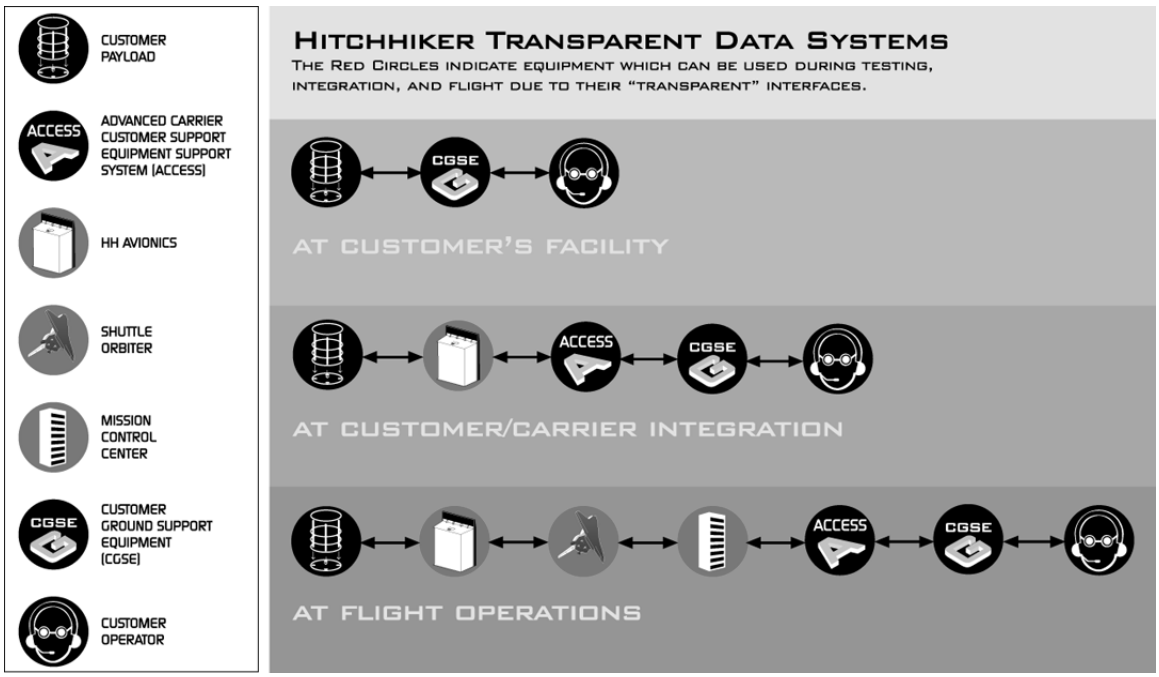

Figure 2-3 Transparent Data System Concept

The Hitchhiker carrier system provides several options for launching small spacecraft from the Shuttle payload bay. Each provides a different satellite envelope and payload environment. These ejection systems are known as the **Pallet Ejection System (PES)** and the **Shuttle Hitchhiker Experiment Launch System (SHELS)**. The PES payload and ejection system is mounted either in a canister or on a pallet prior to Orbiter installation and launch. The SHELS can be mounted on either a pallet or the SHELS launch structure, which attaches to the Orbiter longeron and frame structure.

The general characteristics of the PES launcher system are a maximum spacecraft weight of 150 pounds (68 kilograms), a maximum spacecraft CG offset from separation plane of 10.25 inches (26 centimeters), a maximum spacecraft CG offset from launcher centerline of 0.25 inches (0.64 centimeters), and an ejection velocity range from 1 to 4 feet per second (0.3 to 1.2 meters per second). The general characteristics of the SHELS are a maximum spacecraft weight of 400 or 500 pounds (181 or 226 kilograms) (configuration dependent), a spacecraft CG offset from separation plane range from10.25 inches (26 centimeters) to 24 inches (61 centimeters), a maximum spacecraft CG offset from launcher centerline of 0.25 inches (0.64 centimeters), and an ejection velocity range from 1 to 4 feet per second (0.3 to 1.2 meters per second)

3.0 Point of Contact

Ownership of the Hitchhiker hardware has been transferred to the Launch Service Program Office. It may be contacted as follows:

Launch Service Program Office
Kennedy Space Center, Code VA-B
Kennedy Space Center, FL 32899

4.0 Video Interview Archive

In order to better preserve and transfer some of the knowledge that was amassed during the lifetime of the Hitchhiker program a video recording has been produced and included as Appendix 1 of this document.

5.0 Project Management

Throughout the years that the HH project was active, a very efficient process for flying HH experiments was developed and refined. This process is documented in 870-PLAN-047, *Shuttle Small Payloads Project Office (SSPPO) Project Plan*. This serves as an excellent model for any further HH missions.

The two major documents that define the interfaces and agreements between the Space Shuttle and a HH payload are the Payload Integration Plan (PIP) and the Shuttle Interface Control Document/Drawing (ICD) or Interface Definition Document (IDD). The PIP represents the payload-to-Space Shuttle Program (SSP) agreement on the responsibilities and tasks directly related to integration of the payload into the Space Shuttle, and includes a definition of standard and nonstandard services. The ICD or IDD defines and controls the design of interfaces between the Shuttle Orbiter and the cargo element.

The PIP is based on the appropriate Standard Integration Plan (SIP), which is a template for the PIP. Most HH payloads use NSTS21000-SIP-ATT, *Shuttle/Payload Standard Integration Plan for Attached Payloads*. HH payloads with deployable experiments use NSTS 21000-SIP-DRP, *Shuttle/Payload Standard Integration Plan for Deployable/Retrievable Payloads*.

ICD-2-19001, *Shuttle Orbiter / Cargo Standard Interfaces (Core)*, normally defines integration requirements for trunnion mounted payloads manifested in the Cargo Bay along with any associated Aft Flight Deck components. NSTS-21000-IDD-SML, *Small Payload Accommodation Interface Definition Document*, normally defines integration requirements for payloads that are installed on Shuttle Program provided carriers attached to the Cargo Bay sidewalls. Typically small payloads have minimal power and avionics requirements and require little or no flight crew interaction during on-orbit operations. Unique payload ICDs are derived from these documents.

740-SPEC-008, *Hitchhiker Customer Accommodations Requirements (CARS)*, defines available standard customer interfaces and services provided by the HH carrier systems, the Shuttle Small Payloads Project (SSPP), the Shuttle Program, and NASA to a HH payload customer as well as requirements to be met by the customer in areas such as interfaces, environmental capability, Electro-Magnetic Interference (EMI) control, and safety.

"The Hitchhiker's Guide to I&T" in NASA/CP-1999-209476, *1999 NASA Shuttle Small Payloads Symposium Proceedings,* and NASA-TM-211611, *Integration & Test of Shuttle Small Payloads,* provide information on the Integration and Test (I&T) process for Hitchhiker payloads.

870-MGMT-018, SSPP Risk Management Document, governs the process for managing risks not associated with safety hazards.

870-SFTY-081, System Safety Implementation Plan For The SSPPO, governs the process for managing the safety process in concert with the JSC Payload Safety Review Panel (PSRP).

6.0 Mechanical

870-PLAN-084, *Hitchhiker (HH) Reactivation Plan – Mechanical*, is a detailed plan for the reactivation of the HH mechanical hardware. The mechanical reactivation plan cites the mechanical flight and ground support hardware storage location(s) and lists the mechanical inventory items in storage by part/serial number. It also cites handling/transportation procedures, procedures to re-furbish hardware for flight, and other procedures required to prepare and certify the hardware for flight.

7.0 Electrical

870-PLAN-085, *Hitchhiker (HH) Reactivation Plan - Electrical*, is a detailed plan for the reactivation of the HH electrical hardware. The electrical reactivation plan cites electrical flight and ground support hardware storage location(s) and lists the electrical inventory items in storage by part/serial number. It also cites procedures to re-furbish the electrical hardware for flight and other procedures required to prepare and certify the hardware for flight.

8.0 Ground Systems

870-PLAN-086, *Hitchhiker (HH) Reactivation Plan - Flight Software (FSW) and Ground Data Systems (GDS)*, is a detailed plan for the reactivation of the HH flight software and ground data system. The FSW and GDS reactivation plan cites flight software and GDS hardware storage location(s) and lists the FSW and GDS inventory items in storage by part/serial number. It also cites handling/transportation procedures, procedures to re-furbish the GDS hardware for flight, GDS and FSW integration/testing procedures at the payload level, and the GDS and FSW interface(s) (Technical and Programmatic) at the time of the reactivation plan was written.

9.0 Thermal Systems

870-PLAN-087, *Hitchhiker (HH) Reactivation Plan - Thermal*, is a detailed plan for the reactivation of the HH thermal hardware. The thermal reactivation plan cites thermal flight and ground support hardware storage location(s) and lists the thermal inventory items in storage by part/serial number. It also cites procedures to re-furbish the thermal hardware for flight and the thermal interface and model development/approval coordination cycle at the time the reactivation plan was written.

10.0 Documentation

870-PLAN-088, *Hitchhiker (HH) Reactivation Plan - Documentation*, is a detailed plan for the reactivation of HH Configuration Management (CM). The documentation reactivation plan cites the HH interfaces to JSC and KSC and mission-related documentation development/approval coordination cycles

at the time the reactivation plan was written. It also cites the SSPPO CM documentation practices and SSPP CM & quality management training review presentation.

11.0 Safety

870-PLAN-089, *Hitchhiker (HH) Reactivation Plan* - System Safety, is a detailed plan for the reactivation of HH system safety. The safety reactivation plan cites the SSPPO system safety interfaces to JSC and KSC and mission-related documentation development/approval coordination cycles at the time the reactivation plan was written.

12.0 Mission Assurance

870-PLAN-090, *Hitchhiker (HH) Reactivation Plan - Mission Assurance*, is a detailed plan for the reactivation of HH mission assurance. The mission assurance reactivation plan cites GSFC-wide Quality/ISO practices as a roadmap to restore flight validation for the SSPP hardware/software. It also cites the SSPPO Quality Management Plan.

13.0 Mission Operations

870-PLAN-091, *Hitchhiker (HH) Reactivation Plan – Operations*, is a detailed plan for the reactivation of HH mission operations. The operations reactivation plan cites the HH operations' interfaces to JSC and KSC at the time the reactivation plan was written.